

**Late Season Foraging Activities of *Xenoglossa gabbii*
crawfordi Cockerell**

(Hymenoptera : Apoidea)

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Although there is some information available on the nesting habits for two species of the genus *Xenoglossa* (Linsley, MacSwain and Smith, 1955; Bohart, 1964) virtually nothing is known about the foraging activities of these squash and gourd bees (Hurd and Linsley, 1964, 1967). The discovery of a nesting site of *Xenoglossa gabbii crawfordi* Cockerell in Nogales, Sonora, Mexico on 16 September 1965 furnished information that proved helpful in explaining many field observations that had been previously made elsewhere at the flowers concerning the foraging activity of this squash bee. The nesting site (Fig. 1) consisted of 17 burrows that were confined to a low mound formed between permanent irrigation furrows in a large home garden. The greatest diameter of the mound was about 3 to 4 feet and it was located some 2 to 3 feet from the nearest squash plant. The garden complex consisted mostly of an orchard of a number of varieties of fruit trees, planted closely together, and interspersed with corn, beans, and squash. The area was surrounded by a high walled fence which on the east side protected the garden from both intruders and dust from an adjacent much travelled road.

The squash plantings were the most extensive we had encountered in the Nogales area. Most of these were fall type squashes (*Cucurbita mixta*) and had made excellent growth. The oldest and largest planting was just passed its prime although excellent bloom was present on 15 September, the day the area was first visited. Some mildew and a virus disease were affecting some of the plants. Apparently the orchard was irrigated 2 to 3 times a week and the entrance to the lowest burrows on the mound were just above the high water mark. With each irrigation through capillary action the soil became moist well above the zone of the burrows on the lower portion of the mound. The soil was not cultivated and apparently weeds were controlled by hoeing. The surface soil in the garden compound was of a fairly heavy type, containing considerable clay and had been hauled in and deposited over a gravelly decomposed granitic soil. The depth of the surface soil ranged to about 18 inches.

The squash bee population was fairly large and besides *X. gabbii crawfordi* at least two species of *Peponapis* were present in the squash

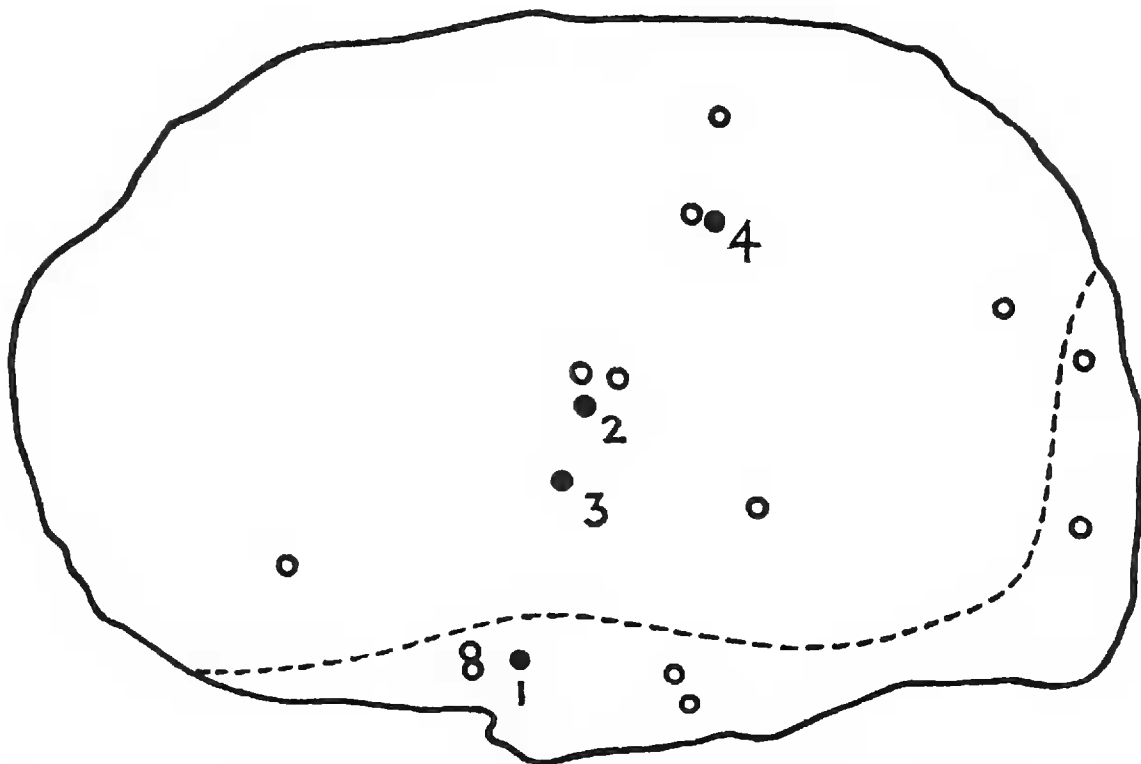


FIG. 1. Diagrammatic representation of the nesting site of *Xenoglossa gabbii crawfordi* indicating location of burrow entrances on soil mound described in text. Occupied burrows (solid circles) are numbered (#1-#4) and are shown in relation to unoccupied burrows (open circles). Dotted line indicates approximate height of flooding at time of irrigation.

flowers. *Peponapis pruinosa* (Say) occurred in fairly large numbers, while *P. utahensis* (Cockerell) was relatively scarce. The squash planting was visited rather late (0730) on the morning of 15 September. At this time all squash bees seen in the flowers were collected. On the following day the patch was visited at 0650 and the nesting site was discovered when a female bee with a full pollen load was seen to disappear into her burrow. Collecting of bees was at once discontinued, but by this time (about 0730) the number of females had been pretty much depleted. A count showed that in the two mornings 39 females of *X. gabbii crawfordi* had been taken. Although the mound contained 17 burrows collecting had inadvertently reduced the number of individuals occupying the site to four. The burrows housing the four individuals are indicated by number in Fig. 1. The squash patch was visited again at 0720 on the morning of 17 September. There was a heavy wind and the temperature had turned cooler (near 50° F). In fact this was the beginning of an unusual cold spell. As the morning progressed it became cloudy. At the start of the survey it was evident that bee #3 had been in and out of her burrow as pollen could be seen at the periphery of her nest. At the nest entrance the bee had cut through

TABLE 1. Activity of *Xenoglossa gabbii crawfordi* Cockerell leaving, returning and plugging burrows. 18 September 1965.

NEST NUMBER					
1			2		
Leaving	Returning	Plugging	Leaving	Returning	Plugging
	0655			0657	
0658			0703		
	0708			0718	
0710			0722		
	0720			0738	
0725					0753
	0739				plug started
0742					0805
	— ^a				plug completed
		0835			0813
		plug noted			plug in- creased to slight mound

NEST NUMBER					
3			4		
Leaving	Returning	Plugging	Leaving	Returning	Plugging
	0659			0716	
0705					0744
	0717				plugged
0723					0750
	0801				activity further increased
		0815			
		plug started			
		0850			
		still not com- pletely closed ^b			

^a Entered without being detected.^b Burrow angles at surface making it difficult to construct the plug.

some straw. The entrance was thus partially fringed with fiber which scraped off pollen as she entered her burrow. Of the four bees, #3 was the only one that exhibited activity. The other females did not unplug their burrows. Bee #3 returned to her burrow for the last time at 0815 and at 0830 started to construct the plug. To do this, she backed up pushing the soil towards the surface, and the operation was repeated until she brought sufficient soil to close the burrow. The period between loads ranged from 2 to several minutes. Just below the surface the burrow angled for a fraction of an inch and this feature appeared to interfere with the construction of the plug. After 50 minutes of effort the female was unable to completely plug the hole. Observations made the following day (18 September) showed that where the burrows tended toward the vertical the bees encountered no difficulty in manipulating and constructing the plug. A survey of the squash plants revealed practically no activity by *X. gabbii crawfordi*, but a number of *Peponapis*, especially *P. pruinosa*, were seen.

The squash patch was again visited on 18 September. During the night it had rained rather heavily in the town but only a light shower had occurred at the nesting site. The orchard had been irrigated the previous day. The arrival time was 0650. It was cloudy, and there was a slight wind but it was not cold (near 60° F). However, by 0725 a strong wind developed. All the burrows were open and as observations later proved, all the bees had not and were not gathering pollen. A constant surveillance of the nesting site was maintained and the results of these observations are presented in Table 1. It was during these observations that the nesting bees and their nests were assigned numbers, which were in the order of the returning bees. The individual females behaved differently. Bee #1 made the most trips. The length of time she required to gather a pollen load ranged from 10 to 14 minutes, while only 2 to 5 minutes were required to deposit the pollen in the nest. Bee #2 spent 15 to 16 minutes per trip gathering pollen and 4 to 6 minutes to deposit it in the nest. On the last trip she was so heavily loaded with pollen that she encountered difficulty in entering her burrow. Bee #3 spent 12 to 37 minutes to obtain a pollen load and 5 to 6 minutes to unload. Bee #4 entered her nest at 0715 from apparently a nectar quest; she did not leave her nest so no information in gathering and unloading pollen was obtained from this individual. Interestingly enough, foraging activity for Bees #1 and #3 was over at approximately 0800. After the final return to the nest a period of at least 14 to 15 minutes elapsed before evidence of plugging the burrow became apparent. Some of the plugs were constructed just

TABLE 2. Late season activity of *Xenoglossa gabbi crawfordi* Cockerell in and about burrows. ^a

Time	Temp. ° F	NEST NUMBER										
		1		2		3		4				
		Showing at entrance	Departing	Returning	Showing at entrance	Showing at entrance	Showing at entrance	Showing at entrance	Departing	Returning		
0710	47.0	0730					0708		0713			
0730	50.0	0732				0731		0823			0715	
0750	54.0	0737						0825				0727
0810	60.0	0738				0736				0828		0731
0830	63.0	0743				0744						
0850	65.0	0748				0748				0757		0737
0930	69.5	0751				0754					0759	
0950	71.5	0753				0757						1000 ^c
1010	75.0	0757										
		0801										
		0802										
		0803		1009 ^c								
0650	50.0	0650								0712		
0710	52.5	0652									0714	
0730	55.0	0655										0720
0750	59.5	0657										
0820	63.5	0659										0730
0840	69.0	0701										0733
		0703										0855 ^e

22 September 1965^b

24 September 1965^d

^a Burrows opened at time of arrival.
^b Survey concluded 1010. Bees 2 and 3 still out.
^c No pollen detectable.
^d Survey concluded 0950. Bee 1 still out, and no activity ever detected in nests 2 and 3.
^e Burrow closed between 0917 and 0925. Temperatures at 0900—72.5°; 0920—75.5°; and 0940—78.0° F.

below the surface of the entrance. The bees generally went directly to their burrows and entered without any hesitation. However, bee #3 on the 0717 return circled the mound before entering and on her last return (0801) she came in with a light pollen load, flew about hesitantly as if aware of our presence. Because of the light pollen load and the fact that she spent 37 minutes away from the nest it might be assumed that part of the period was utilized in taking nectar.

The nesting site was next visited two days later on 20 September at 1530. At this time Burrow #3 was open but Burrows #1, #2, and #4 were plugged just below the entrance. The nesting site was revisited on 21 September from 0640 to 1020. It was a clear and windless morning, although the cool weather of the past week continued. The temperature at sunrise was 41° F. All burrows were open at time of arrival, and the bees were still in them. The bees appeared reluctant to leave the burrow and from time to time they would move towards the entrance as if testing the situation and then retreat into the burrow. As they approached the entrance they could be detected by a tiny light, probably a reflection from the anterior ocellus. It was definite and produced a rather unusual effect and showed before any part of the bee could be distinguished. The time between making appearances tended to shorten as the period for the bee to leave the nest approached. This characteristic appearance and disappearance at the nest entrance was observed shortly after arrival at the nesting site.

Bee #1 left her burrow at 0737, bee #2 at 0807, bee #3 at 0830, and bee #4 left the earliest of all, at 0720. At the time the observations were concluded (1020) neither bees #1, #2, or #3 had returned to their nests. Bee #4 returned at 0920 with a light pollen load, left again at 0940 and returned at 1000 without pollen.

The cool weather that had prevailed apparently exerted an adverse influence on the quality of the squash flowers, but this condition also probably involved a virus disease. Flowers on young, apparently healthy plants, were normal.

Before leaving the squash patch, a survey at 1015 showed one *X. gabbii crawfordi* working on the flowers for nectar. The three bees that did not return were probably also visiting flowers for nectar. During the morning temperatures were taken at 20-minute intervals and the results are as follows:

TIME	TEMP. ° F.	TIME	TEMP. ° F.	TIME	TEMP. ° F.
0640	41	0800	54.5	0920	63.5
0700	43	0820	58.5	0940	66.0
0720	45	0840	61.0	1000	67.0
0740	50	0900	61.5	1020	68.5

The nest site was visited again at 1245. Burrows #1, #2, and #4 were plugged about $\frac{1}{4}$ inch below the entrance. Many flowers never completely opened, but the pollen supply was in excess of that which the bees could utilize.

On 22 September the nesting site was kept under constant observation from 0705 until 1010. All burrows were open on arrival. The weather was clear, calm and it was somewhat warmer than on the preceding day. The time of appearance in the burrows, leaving and returning to the nest along with temperatures, are given in Table 2. The information clearly shows that there was considerable variation in the individual action of the four bees. Bee #4 was the first to leave her burrow. Although she was the only one that foraged for pollen she made only two trips and returned each time with only partially completed loads. She left her nest at 0715 for the first time and returned at 0725. She departed for the second load at 0731 and returned in 6 minutes at 0737. At 0757 she showed and left her burrow at 0759. At 1000 she returned to her burrow without a pollen load, and apparently spent the time away from the nest seeking nectar. After a number of appearances at the nest entrance, bee #1 left at 0803 and returned without detectable pollen at 1009. During the period she was away from her nest the orchard was irrigated and moisture had crept for a couple of inches beyond the entrance to her burrow. This change in conditions apparently caused her to fly repeatedly around and about the entrance before entering. Apparently the time she spent out of her burrow was in search of nectar. Bee #2 left her nest at 0759 and bee #3 at 0825. Neither of these returned before the survey was completed. There is little doubt that they were seeking nectar. Late in the season there appears to be the tendency for the squash and gourd bees (*Peponapis* and *Xenoglossa*) to search for nectar late into the day. At the close of the 22 September survey (1010) the squash patch was examined and 5 female *X. gabbii crawfordi* were found. None of these showed any evidence of gathering pollen. At 1245 an examination of the nesting site revealed that the burrows of bees #2 and #3 were unplugged.

On 23 September, the nesting site was visited at 1110. It was hot and still. The entrance to nests #1 and #4 were plugged at least $\frac{1}{4}$ inch below the surface, while nests #2 and #3 were open with no evidence of activity. No change noted when the site was again examined at 1140. A survey of the garden showed that the older squash plants were in a state of rapid decline. The flowers were few and most failed to open in a normal fashion, probably due to virus and mildew. In the younger planting conditions were much better. There were many

normal flowers and there were numerous *Peponapis* either resting or getting nectar. Two *X. gabbii crawfordi* were seen, neither gathering pollen. One of these was encountered at 1145 and in a brief period she moved to 3 or 4 flowers, apparently in search of nectar.

The last extensive survey was conducted from 0645 to 0950 on 24 September. The day was clear and still and the entrances to the burrows were open at time of arrival. No activity in nests #2 and #3 was detected throughout the survey and subsequent observations indicated that the bees associated with these nests were finished for the season. The activity encountered in nests #1 and #4 together with temperatures is given in Table 2. Bee #1 appeared at her burrow entrance a number of times and left at 0703. She had not returned at the time the survey was concluded at 0950. Bee #4 appeared once at 0712 and left the burrow two minutes later. She brought in two loads of pollen. The last one was at 0730. She left again at 0733 and returned at 0855 without a pollen load. She plugged her burrow shortly after this.

At 0955 a survey of the squash patch showed that there were two *X. gabbii crawfordi* gathering nectar. *Peponapis* were not as abundant as on the previous day, and bumble bees were present. During the survey squash flowers were removed from the plants and were placed about the nesting site. Both *Peponapis* and *X. gabbii crawfordi* visited these flowers. Among the flowers were some that were normal and others that were not. It appeared that the squash bees showed a decided preference for the normal flowers. The *X. gabbii crawfordi* visiting these flowers apparently were in quest of nectar, although at 0828 one with a pollen load looked at a flower and continued on.

The last observation of the nesting site before the burrows were excavated on 2 October was made on 25 September. At the time of arrival at 1030 Burrow #4 was plugged and at time of leaving at 1100 Burrow #1 was also plugged. Flowers in the younger squash planting were in good condition. No *X. gabbii crawfordi* were seen visiting the flowers but *Peponapis* and bumble bees in particular were numerous and active.

It is regrettable that the nesting site was not discovered at an earlier date. This would have afforded an opportunity to study the activity of the bees during the height of the pollen gathering period. As it turned out, observations covered the end of this period and the activity of the bees at the close of the nesting season. The behavior exhibited through this transition was most marked. During the active pollen gathering period the females gather pollen and nectar during the early

TABLE 3. Latest period that females of *Xenoglossa gabbii crawfordi* were taken in surveys conducted in several localities in Mexico.

Locality	Date	Sunrise	Time period	Number of individuals	Pollen load
Mazatan	9/9/64	—	0730 to 0745	3	absence to light
8 mi. S. E. Culiacan	9/14/64	—	0600 to 0615	11	light to heavy
15 mi. N. Mazatlan	9/15/64	—	0545 to 0600	4	light to heavy
3 mi. N. Las Cruces	9/27/64	0700	0610 to 0625	1	heavy
7½ mi. E. Colima	10/11/64	—	0730 to 0745	1	light
Colima	10/12/64	0700	0750 to 0805	1	heavy
12 mi. S. E. Manzanillo	10/14/64	0715	0745 to 0800	1	light
Playa de Santiago, Manzanillo	10/15/64	0702	0715 to 0730	1	medium
13 mi. N. W. Mazatlan	10/21/64	0717	0645 to 0700	1	heavy
15½ mi. E. Navajoa	10/23/64	0630	0620 to 0635	1	heavy

morning hours and usually retreat to their burrows and plug them at an early hour. At the close of the principal pollen gathering season the habits of the females undergo a profound change. They no longer leave their nests at an early hour and they may or may not gather pollen. If they do not gather pollen there is a tendency for them to remain away from their nest for periods ranging up to more than two hours. During this time they visit flowers, and probably are only interested in taking nectar.

The unusual cold period that set in shortly after the nesting site was discovered may have hastened the close of the season. At the time the nesting site was excavated on 2 October all evidence pointed to the fact that activity was rapidly drawing to an end. Of the four bees under observation only one remained. Her last observed action was most unusual for she came out of her burrow and immediately entered another burrow, separated from hers by 7 mm.

Evidence supporting the fact that the present season may have been an early one is found in observations made at Cibuta, Sonora, Mexico, on 25 October 1964. Cibuta is about 30 miles south of Nogales. A patch of zucchini type squash was examined from 0930 to 0945 and *X. gabbii crawfordi* females were observed gathering pollen.

Based on observations made in Mexico, *X. gabbii crawfordi* activity in the field during the active pollen gathering period starts about 20 minutes before it is light enough to capture the bees without the aid of a light. Such observations were made in the vicinity of Mazatan, Culiacan, Mazatlan, Colima and Manzanillo. Activity by the females of this species also ceased at a relatively early hour. In a number of fields squash bee activity was followed at 15-minute intervals and the latest period in which female *X. gabbii crawfordi* were taken along with other pertinent information is given in Table 3. The data clearly shows that the females terminate their field activity at a rather early hour and usually long before the flowers show any signs of closing.

Observations at the nesting site clearly illustrate why in midseason female *X. gabbii crawfordi* are only likely to be collected in early morning, while in late season early morning collecting would probably yield nothing. However, during this latter period late morning collecting is likely to be fruitful.

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RECENT LITERATURE

A CLASSIFICATION OF THE LARGE CARPENTER BEES (XYLOCOPINI) (HYMENOPTERA : APOIDEA). By Paul D. Hurd, Jr., and J. S. Moure, C.M.F. University of California Publications in Entomology, vol. 29: vi + 365 pp., including a frontispiece and 244 figs. in the text, most of them grouped terminally. University of California Press, Berkeley and Los Angeles; Cambridge University Press, London. 31 December 1963. \$7.50.

This remarkable work results from years of study by the authors, both independently and together, and includes a detailed investigation of the world literature. Starting with those of the head, structural characters proven useful in the taxonomy were designated serial numbers, with lettered subdivisions. These numbers and letters have been used in the descriptions (designed for computer use), each as a separate paragraph. As a result, tracing or comparison of characters in various taxa is simple and immediate, though the descriptions are exhaustive.

In many subgenera keys to species are provided, chiefly adapted from recent literature with comments on later studies. Of the many new species discovered, only those used as type species for certain new subgenera are actually described. The work includes a synoptic catalogue of all taxa, in parts, as appropriate to the text. The list of names as applied in the genus *Xylocopa* Latreille contains many new synonymies.—HUGH B. LEECH, *California Academy of Sciences, San Francisco*.